
Appendix E

**Use/Generation, Emission, and Release
Estimates for Mercury, Hexachlorobenzene,
Dioxins and Furans, and PCBs from Ontario
Sources in the Lake Superior Basin**

Introduction

The majority of information contained in this loading estimates document is based on a consultants report to Environment Canada entitled:

Zero Discharge Strategy for Lake Superior: Fishing for Sources of Contaminated Water prepared by Shirley Thompson, M.Eng., under contract #KA401-4-0118, 1994.

Copies of this report are available from the Lake Superior Issues Coordinator, Restoration Programs Division, Environmental Conservation Branch, Ontario Region, Environment Canada, 4905 Dufferin Street, North York, ON M3H 5T4. Please enclose a self-addressed stamped envelope, with sufficient postage for a 100 page report, or you may request this document on 3.5" disk, MS-DOS formatted.

E.1. Hexachlorobenzene

Table E-1. Ontario Sources and Emissions.

Source/Use Category	Emissions (kg/yr)			Use, Disposal, Soils (kg/yr)
	Water	Air	Total Releases	
INDUSTRIAL				
Forest products ^a	NA	NA	NA	
Chlorinated solvent prod.	NA	NA	NA	
Mining				
Wood preserving				2.20 ^b
Contaminated soils (NWP)				2.42 ^c
Industrial total				4.60
INCINERATION				
Medical incineration	NA	0.08	NA	
Small incinerators	NA		NA	
Incineration total	NA	0.08	0.08	
FUEL COMBUSTION				
Coal ^d		0.01	0.01	
Wood ^e		0.005	0.005	
Diesel				
Leaded gasoline				
Unleaded gasoline ^f		<0.001		
Fuel total		0.015	0.015	
MUNICIPAL/RESIDENTIAL				
Landfills				
Wastewater treatment plants	0.17		0.17	
Drycleaners				0.11 ^g
Runoff/overflows	0.04		0.04	
Municipal total	0.21	0	0.21	0.11
COMMERCIAL PRODUCTS				
Pentachlorophenol use				
Chlorinated solvents				
Pesticide use				NA
Commercial products total				
ANTHROPOGENIC TOTAL	0.21	0.09	0.30	4.71

Note: the majority of these estimates are from Thompson, 1994, except as amended in the attached addendum.

Addendum to Thompson Report for Hexachlorobenzene

- ^a Pulp and paper - releases detected during the 1990 MISA monitoring year, and reported by Thompson (1994) have been discounted, due to the reported unreliability of the reported measures. No emission factors are available for either liquid effluent, recovery boilers or product/waste.
- ^b Quantity (kg/yr) of HCB contaminated products treated by Northern Wood Preservers.
- ^c Quantity (kg) of HCB in soils of Northern Wood Preservers and in sediments of Thunder Bay Harbour.
- ^d Coal burning - Thompson reports 640,000 tonnes of coal are burned per year in the Lake Superior basin. Cohen et al (1995) reports an emission factor of 1.6×10^{-11} g HCB/g coal, yielding a total estimated emission of 10 grams/year.
- ^e Wood burning - Thompson reports 580 kg/person/year wood burned, 87,000 tonnes /year in the basin. Cohen et al (1995) report an emission factor of 6.0×10^{-11} g HCB/g wood, for a total estimated emission of 5 grams/year.
- ^f Unleaded gas - Thompson reports 37,500 households, and assuming one vehicle/household, driving 21,000 km/yr, with a reported (Cohen et. al 1995) emission factor of 2.4×10^{-11} g HCB/km driven, yields an estimated emission of 0.019 grams/year, reported as <0.001 kg/year.
- ^g HCB contamination in sludge residue (disposed of as hazardous waste) from dry-cleaning (kg/yr).

E.2. Dioxins And Furans

Table E-2. Ontario Sources and Emissions

Source/Use Category	Emissions (g/yr)			Use, Disposal, Soils (g/yr)
	Water	Air	Total Releases	
INDUSTRIAL				
Forest products ^a	0.47	0.09	0.56	13.18 ^b
Mining/sintering ^j		21.8	21.8	
Wood preserving	1.52	NA	1.52	1.53 ^c
Contaminated soils (NWP)				31.38 ^d
Industrial Total	1.99	21.89	23.88	14.71
INCINERATION				
Medical incineration ^e		0.13	0.13	94 ^f
Small incinerators	NA	NA	NA	
Incineration total		0.13	0.13	94
FUEL COMBUSTION				
Coal		0.89	0.89	0.001 ^g
Wood ^h		0.08	0.08	
Natural gas		0.05	0.05	
Gasoline		0.02	0.02	
Fuel total		1.04	1.04	0.001
MUNICIPAL/RESIDENTIAL				
Wastewater treatment plants	0.04	0.01	0.05	
Municipal total	0.04	0.01	0.05	
COMMERCIAL PRODUCTS				
Pentachlorophenol use		0.27	0.27	
PCBs ⁱ			0.003	70 ⁱ
Commercial products total		0.27	0.27	
ANTHROPOGENIC TOTAL	2.03	23.34	25.37	108.71

Note: The majority of these estimates are from Thompson, 1994, except as amended in the attached addendum.

Addendum to Thompson Report for Dioxins and Furans

- ^a For pulp and paper, a 1991 baseline required the use of data based upon elemental chlorine bleaching. More detailed TEQ emission factors are available for ClO_2 bleaching and various technologies, but bleaching technology is changing rapidly in the Canadian portion of the basin. Verification of bleaching technology and application of updated estimates will be undertaken after compliance with government regulations through technological change has occurred. Note that the United States estimates are based upon 1/2 of the detection limit, and do not include air or product estimates.
- ^b TEQ present in product (bleached kraft pulp) and in sludge from recovery boilers and effluent treatment systems (g/yr)
- ^c TEQ contained in products (ties, poles) treated at Northern Wood Preservers and in process waste (landfilled) (g/yr).
- ^d Contaminated soils on the Northern Wood Preservers property and sediments in Thunder Bay Harbour (grams present). This is not an annual rate of use or disposal.
- ^e For biomedical waste incineration, Thompson uses 4.1×10^{-9} g/g TEQ although the United States' estimate of 1.1×10^{-9} g/g TEQ is more appropriate. However the Thompson estimate was used, and it was assumed that all four biomedical incinerators in the Canadian basin were operating during the baseline (1990) year. Since then two have closed, reducing TEQ by approximately 50%.
- ^f For the ash estimates from biomedical incinerators, 9.4 tonnes of ash was assumed to be produced, with a content of 10 $\mu\text{g/g}$ TEQ, yielding 94 grams/yr TEQ to landfill.
- ^g Ash content (TEQ) produced by Thunder Bay Thermal Generating Station (landfilled) (g/yr).
- ^h For wood combustion, an emission factor of 1.0×10^{-3} mg TEQ/tonne was used instead of the 2.4×10^{-2} mg/tonne included in Thompson, resulting in an estimated emission of 0.08 g/yr.
- ⁱ For PCBs, contamination by PCDF ($1.5 \mu\text{g PCDF/g PCB}$), with an assumed TEQ of 0.1, yields 70 grams TEQ in the stored and in-use PCBs (400 tonnes) in the basin. At this time, no estimate for dioxin TEQ is available for the Lake Superior Basin. Dioxins from PCB spills were similarly estimated from the unrecoverable releases to the environment (21.6 kg/yr PCB) in the Canadian basin.
- ^j Stack test data for Algoma Ore Division iron sintering plant in Wawa, Ontario – 1994.

E.3. Mercury

Table E-3. Ontario Sources and Emissions.

Source/Use Category	Emissions (kg/yr)			Use, Disposal, Soils (kg/yr)
	Water	Air	Total Releases	
INDUSTRIAL				
Forest products	10.99	11.0	21.99	.001
Mining ^a	0.4	604	604.4	
Metal finishing	1.53		1.53	
Photoprocessing	.005	.0004	0.005	
Industrial total	12.92	615.00	627.92	0.001
INCINERATION				
Medical incineration ^b		0.12	0.12	.02
Small incinerators				
Cremation		1.1	1.1	
Incineration total		1.22	1.22	0.02
FUEL COMBUSTION				
Thunder Bay Thermal...	0.44	100	100.4	10.0
Coal		5.0	5	
Wood		0.34	0.34	
Natural gas		12.0	12	
Oil		8.0	8	
Fuel total	0.44	125.34	125.8	10.0
MUNICIPAL/RESIDENTIAL				
Wastewater treatment plants	3.89	4.63	8.52	2.08
Runoff	0.7		0.7	
Landfills		15.0	15	
Hospital/dental	26.0	1.1	27.1	
Pharmaceutical		1.26	1.26	
Municipal total	30.59	21.99	52.58	2.08
COMMERCIAL PRODUCTS				
Batteries				300
Lighting		5.4	5.4	16.2
Thermometers		6.2	6.2	
Thermostats		9.0	9.0	
Switches		0.2	0.2	
Pigments		5.6	5.6	
Paint		0.12	0.12	
Fungicides		1.2	1.2	4.27
Instruments (other)		13.1	13.1	52.35
Commercial products total		40.81	40.81	372.82
ANTHROPOGENIC TOTAL	43.95	804.36	848.31	384.92

Addendum to Thompson Report for Mercury

- ^a Includes 600 kg/yr from the Algoma sintering plant in Wawa, Ontario, based on 1994 stack test data. The Algoma facility was closed in June 1998.
- ^b Hospital/dental emissions estimates are derived from the 4 biomedical incinerators in operation in 1990. Since that time two of them have shut-down, reducing mercury emissions from this source by approximately 50%.
- ^c New information based on Pang (1997) was used to extrapolate from Minnesota statewide estimates to the Lake Superior basin population. See page D-7 for reference.

E.4. Polychlorinated Biphenyls

E.4.1 PCBs in (Ontario) basin:

	STORAGE (kg)	USE (kg)
Industrial		
Abitibi Price	15847	
Provincial papers	9568	
Algoma	1950	
AVENOR	40679	57186
Domtar	6195	7786
Great West Timber	2	
James River	35870	17691
Kimberly Clark	7562	83665
McMillan Bloedel	185	59
Minnova	90	
Noranda GECO	700	950
Northern Wood Pres.		80
Teck-Corunua		48
Utilities		
Nipigon Hydro		270
Ont. Hydro - Matathon	800	
Ontario Hydro- Thunder Bay	14379	1813
Schreiber Hydro-Electric	6415	
Thunder Bay Hydro	28738	7740
Municipal/Prov./Federal		
Thunder Bay-Bare Point		36
Thunder Bay-Town Hall		1160
Lakehead Bd. of Education	10	4028
Lakehead Catholic Sc. Bd.		910
McKellar General Hospital		5144
Min. Govt. Services	569	
Public Works	2789	200
Transport Canada	422	1405
Commercial		
856595 Ont. Ltd.	50	
Canadian Grain Commission	7506	
Canadian National Railway	200	4.5
Canadian Pacific Railway	1481	
Cargill Grain	36	40
CKPR	6	
Manitoba Pool Elevators	2364	4552
Ogilvie Mills Ltd	4312	
Parrish and Heinbacker		1892
Port Arthur Shipbuilding	290	
Proboard Manufacturing	2067	
Saskatchewan Wheat Pool	476	12011
Sears Ltd.		933
United Grain Growers	5	8946
UTDC-Thunder Bay	50	
Weldwood Canada	324	
Western Grain	36	61
Westinghouse	50	

E.4.2 PCB Inventory in (Ontario) the Lake Superior Basin

Type	Storage	Use
Industrial	134200	194830
Utilities	57880	11300
Municipal	4360	14815
Commercial	22140	32700
TOTAL	218580	253645
GRAND TOTAL		472225

Note: PCBs in Ontario are typically measured in litres. Conversion to kg assumed a density of 1.15 kg/L. In the United States estimates, the reported values are converted to "pure PCB" while the Ontario values are "PCB contaminated materials/fluids." In this respect the values for each country are difficult to compare.

E.4.3 PCB Emissions due to Spills and Accidental Releases in the Canadian Basin

It is assumed that 0.4 percent of the PCB's in use are spilled annually (see U.S. loss estimates), with a 99.7 percent efficiency of cleanup when spilled to land. It is assumed that 1.7 percent of spills take place to media (water for example) where recovery is only 50 percent. Further it is assumed that 7.2 mg/kg of PCB's spilled are lost to the atmosphere by evaporation. Based on these estimates it may be that 21.6 kg/yr PCB's are irrecoverably lost to the Canadian portion of the basin. No estimates are available for vaporization of PCB's from use.

Inventory in Use (Kg)	Spills (Kg/yr)	Emissions (Kg/yr)			
		Land	Air	Water	Total
472225	1889	5.6	0.013	16	21.6